Comparing a TLS point cloud with UAV point clouds

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Agenda

- Motivation
- Conclusion
- Field work
- Office work
- Final note
Motivation

- Lerch Weber Corporation
  - Swiss surveying company
  - UAV since 2011, Gatewing X100
  - 2017 senseFly eBee Plus
- 2017 Trimble SX10
  - Total station
  - High accuracy laser scanner
- TLS point cloud versus UAV point clouds
- Gravel pits with UAV technology without GCPs?
Conclusion

- Gravel pits with UAVs and not using GCPs?
- Yes, but RTK on the UAV required!
- Mean difference between SX10 point cloud
  - UAV point cloud **with** GCPs = 6 cm
  - UAV point cloud **without** GCPs = 10 cm
- Accuracy sufficient for most gravel pits
Field work 1

- Gravel pit in Switzerland
  - 200 x 200 m
  - flat areas, steep faces
  - 40 m difference in height
- 9 ground control points
  - yellow plastic plates
  - evenly distributed, horizontally + vertically
- GNSS Trimble R10 / Swiss VRS network
Field work 2

- 4 SX10 stations
- As "free stations"
  - 3 known points measured
  - 2 people required
- Medium point density
- ¾ hours per station
- Accuracy 3.0 mm at 200 m
- Scans merged and georeferenced in SX10
Field work 3

- eBee Plus by senseFly
  - 2 flights
  - 100 + 150 m above ground
- RTK-feature turned on
- Planning with eMotion
- Swiss VRS network
- 14 minutes / 180 pictures
Visual results

UAV point cloud → TLS point cloud

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Office work 1

- Point Cloud (UAV + RTK + no GCPs) = Point Cloud (UAV + RTK + GCPs)
- 4 UAV point clouds
- 9 GCPs versus 0 GCPs

<table>
<thead>
<tr>
<th>UAV Point cloud number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight number</td>
<td>1</td>
<td>2</td>
<td>1 &amp; 2</td>
<td>1</td>
</tr>
<tr>
<td>Flight height</td>
<td>100 m</td>
<td>150 m</td>
<td>100 &amp; 150 m</td>
<td>100 m</td>
</tr>
<tr>
<td>Ground sample distance [cm/pixel]</td>
<td>2.5</td>
<td>3.6</td>
<td>2.5 &amp; 3.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Number of GCPs used</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Office work 2

- 4 UAV point clouds, accuracy a few centimetres
- SX10 point cloud, accuracy a few millimeters
- SX10 point cloud = Reference point cloud
- Comparison with CloudCompare

<table>
<thead>
<tr>
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<th>1</th>
<th>2</th>
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<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of GCPs used</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mean difference between SX10 point cloud and UAV point cloud [cm]</td>
<td>5.5</td>
<td>6.4</td>
<td>9.4</td>
<td>9.5</td>
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<tr>
<td>std.dev [cm]</td>
<td>5.2</td>
<td>5.9</td>
<td>5.9</td>
<td>5.8</td>
</tr>
</tbody>
</table>
Final Note

- **Latest job**
  - 2.5 km²
  - **Without** RTK: 20 GCPs, 4 hours
  - **With** RTK: 4 GCPs, < 1 hour

- One measurement = No measurement
- RTK reduces need of GCPs enormously!
Thank you for your attention!